MMCEVB1200PV Evaluation Board (EVB) User's Manual

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M•CORE development systems include open-construction printed circuit boards that contain static-sensitive components. These boards are subject to damage from electrostatic discharge (ESD). To prevent such damage, you must use static-safe work surfaces and grounding straps, as defined in ANSI/EOS/ESD S6.1 and ANSI/EOS/ESD S4.1. All handling of these boards must be in accordance with ANSI/EAI 625.

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Section 1 Introduction

This user's manual explains connection, configuration, and operation information for the MMCEVB1200PV Evaluation Board (EVB), a standalone development tool of Motorola's M•CORE™ family. The EVB lets you use the Picobug debug monitor, through an RS232 connection to your computer. In conjunction with the Picobug monitor, you may use the GNU source-level debugger. The EVB also has a OnCE™ connector, enabling you to use a debugging application that requires one.

Motorola's FLASH programmer lets you download your code into the EVB's SRAM (for execution) or FLASH memory (for storage in non-volatile memory). Should your application overwrite system software in the FLASH memory device, you can use the FLASH programmer to restore the system software.

A separate EVBPROTO breadboard comes with your EVB, enabling you to add your own components to EVB circuitry. The power supply that comes with your EVB converts line power to 5-volt power.

1.1 EVB Features

The EVB features:

- 512K-by-16 FLASH memory, at 90 nanoseconds
- Two 64K-by-16 SRAM memories, at 70 nanoseconds
- 3.3-volt power regulator
- Power supply that converts line power to 5-volt power
- Two RS232 channels for serial communication. These channels use internal universal asynchronous receiver/transmitters (UARTs).
- 14-pin JTAG/OnCE debug connector
- Three 40-pin I/O and interrupt connectors
- Separate breadboard printed circuit board, with three ribbon cables and extra 2-by-20-pin headers
- Address decoding: direct chip select from the processor.
- Jumper headers for such configuration items as FLASH byte/word use.
- Motorola's FLASH programmer
- Picobug debug monitor and GNU source-level debugger (from the Free Software Foundation)

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- Ability to use debugging software from one or more other manufacturers. (An example is SingleStep debugging software, from Software Development Systems.)

1.2 System and User Requirements

You need an IBM PC or compatible computer, running the Windows 95 or WindowsNT (version 4.0) operating system. The computer requires a Pentium (or equivalent) microprocessor, 16 megabytes of RAM, 50 megabytes of free hard-disk space, an SVGA color monitor, and an RS232 serial-communications port. You also need a C compiler, an M•CORE assembler, and an M•CORE linker. To use the Picobug debug monitor, you also need Hyperterminal or a comparable terminal-emulation program.

To get the most from your EVB, you should be an experienced C or M•CORE assembly programmer.

Your EVB requires 5-volt (± 0.25 volt) input power, at 250 milliamperes. The power supply that comes with your EVB provides this power from line power.

1.3 EVB Layout

Figure 1-1 shows the layout of the EVB.

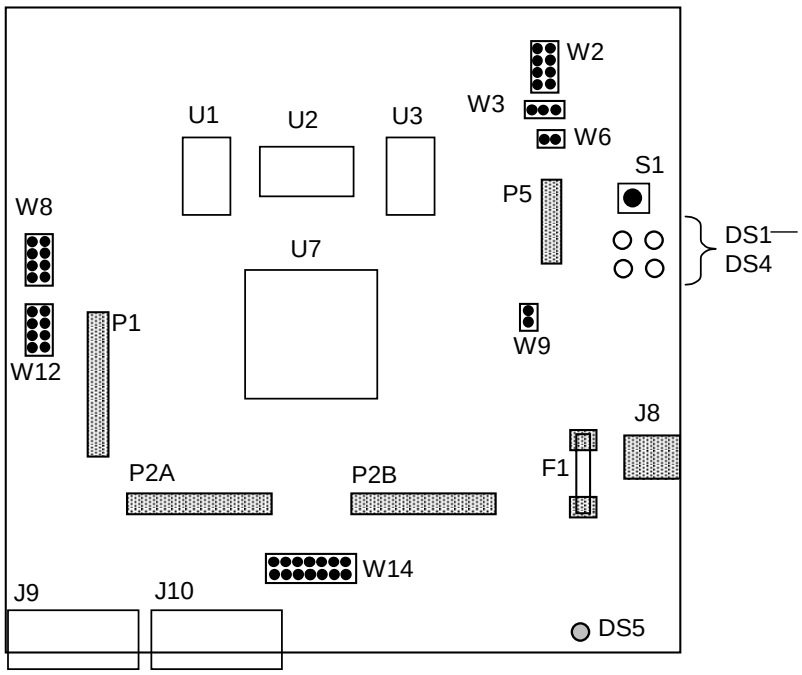

Figure 1-1 MMCEVB1200PV Evaluation Board

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Jumper header W2 selects the SRAM bank 1 chip select. Jumper headers W3 and W6 configure byte or word mode for FLASH memory. Jumper header W8 selects the SRAM bank 0 chip select. Jumper header W9 selects the startup vector. Jumper header W12 selects the FLASH chip select. Jumper header W14 enables or disables the serial ports, and also configures the EVB for its self-test.

Connectors P1, P2A, and P2B are the I/O and interrupt connectors. Connector P5 is the OnCE connector. Connector J8 is the power connector. Connectors J9 and J10 are the RS232 serial communication connectors: J9 is for user applications that do not require control signals, J10 is for system software or other applications that do use control signals.

Switch S1 is the reset switch. Location F1 is for the EVB fuse.

Yellow LEDs DS1 through DS4 light to confirm that the EVB passed its self-test. Green LED DS5 lights to confirm that the EVB is receiving +5-volt input power.

The MMC2001 resident MCU is at location U7. SRAM memory devices are at locations U1 and U3. The FLASH memory device is at location U2.

Some unpopulated EVB locations are available for users who want to add optional extra functionality. For example, specific users may want to install a backup battery connector at location P6 (between connector P5 and jumper header W9). Other specific users may want to install low-frequency and high-frequency external coaxial oscillator input connectors at locations J5 and J6, respectively. (These locations are below and to the right of jumper header W9.)

Table 1-1 lists EVB specifications.

Table 1-1 MMCEVB1200PV Evaluation Board Specifications

Characteristic	Specifications
MCU extension I/O ports	HCMOS compatible
Operating temperature	0° to 40° C
Storage temperature	-40° to +85° C
Relative humidity	0 to 90% (non-condensing)
Clock	32 MHz
Power requirements	5 volts dc, from a separate power source
Dimensions	5.75 x 6.0 inches (146 x 152 mm)
Weight	4.5 ounces (128 g)

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1.4 Breadboard Layout

Figure 1-2 shows the layout of the EVBPROTO breadboard.

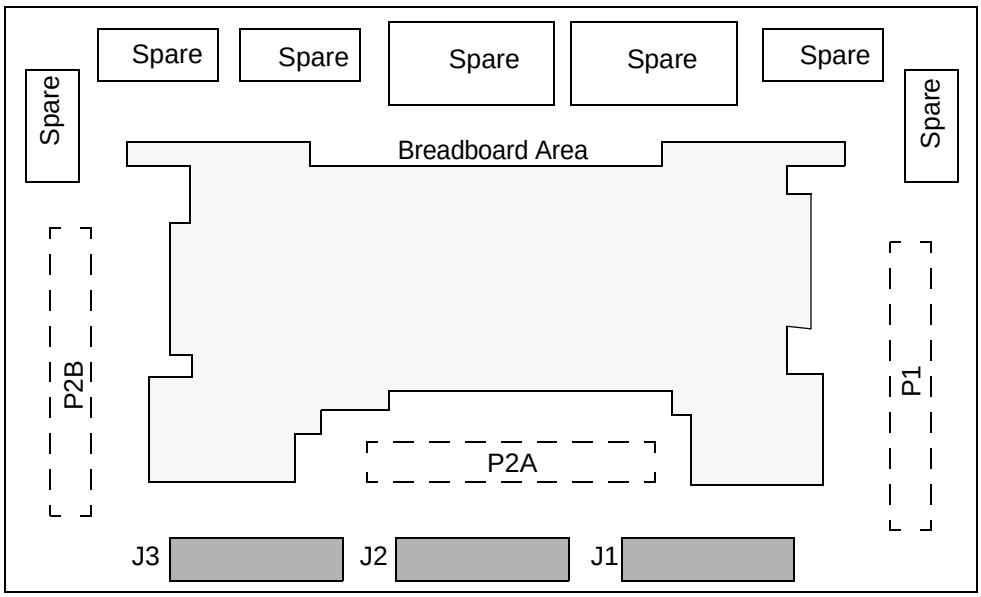

Figure 1-2 EVBPROTO Breadboard

Connector J1 connects to EVB connector P1 via a ribbon cable. This makes EVB P1 signals available at the mounting holes of the EVBPROTO P1 header pad.

Connector J2 connects to EVB connector P2A via a ribbon cable. This makes EVB P2A signals available at the mounting holes of the EVBPROTO P2A header pad.

Connector J3 connects to EVB connector P2B via a ribbon cable. This makes EVB P2B signals available at the mounting holes of the EVBPROTO P2B header pad.

The main breadboard area is at the center of the board. Ground (GND) and 5-volt power (VCC5V) connection points are identified at the edges of this area.

The seven spare pads are in three sizes:

- 50 mils pitch by 220 mils width,
- 25.6 mils pitch by 254 mils width, and
- 50 mils pitch by 380 mils width.

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Table 1-2 lists EVBPROTO specifications.

Table 1-2 EVBPROTO Breadboard Specifications

Characteristic	Specifications
MCU extension I/O ports	HCMOS compatible
Operating temperature	0° to 40° C
Storage temperature	-40° to +85° C
Relative humidity	0 to 90% (non-condensing)
Power requirements	5 volts dc, from an MMCEVB1200PV
Dimensions	5.38 x 3.88 inches (136 x 98 mm)

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Introduction

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Section 2 Configuration

This chapter explains how to configure your EVB, and how to hook it up to your computer system.

2.1 Setting Jumper Headers

Your EVB has seven jumper headers, numbered from W2 through W14. **Table 2-1** is a summary of settings for these headers; **2.1.1 Setting the SRAM Bank 1 Header (W2)** through **2.1.6 Setting the Serial Port Enable Header (W14)** give additional information.

NOTE: *The EVB does not use jumper header numbers W1, W4, W5, W7, W10, W11, or W13.*

Table 2-1 Jumper Header Positions

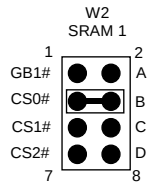
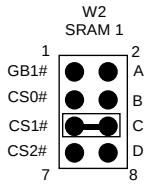
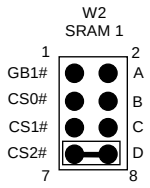
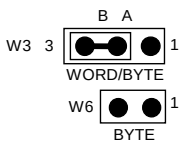
Header	Position	Effect
SRAM Bank 1 Select, W2 (Only 1 jumper in this header; do not use position A.)		Selects chip select 0 to control SRAM bank 1.
		Selects chip select 1 to control SRAM bank 1. **Factory setting.**
		Selects chip select 2 to control SRAM bank 1.
FLASH Byte/Word Select, W3, W6		Configures word mode for FLASH memory. **Factory setting.**

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Table 2-1 Jumper Header Positions (Continued)

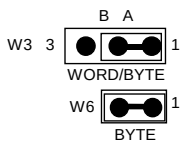
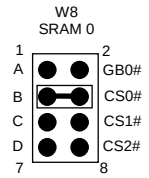
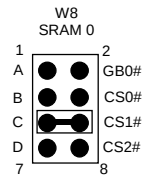
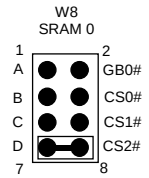
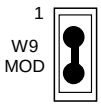
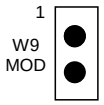
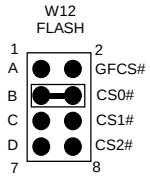
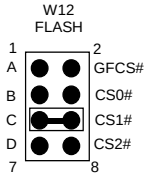
Header	Position	Effect
FLASH Byte/Word Select, W3, W6 (continued)		Configures byte mode for FLASH memory.
SRAM Bank 0 Chip Select, W8 (Only 1 jumper in this header; do not use position A.)		Selects chip select 0 to control SRAM bank 0.
		Selects chip select 1 to control SRAM bank 0.
		Selects chip select 2 to control SRAM bank 0. **Factory setting.**
Startup Vector Select, W9		Upon power-up, selects the startup vector from the lowest address of the external chip-select 0 device. (Usually this is FLASH memory.) Correct configuration for EVB self-test. **Factory setting.**
		Upon power-up, selects the startup vector from the lowest address of MCU internal ROM. Invokes the Mbug debugger. Also the correct setting for the FLASH programmer.
FLASH Chip Select, W12 (Only 1 jumper in this header; do not use position A.)		Selects chip select 0 to control FLASH memory. **Factory setting.**
		Selects chip select 1 to control FLASH memory.

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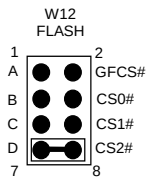
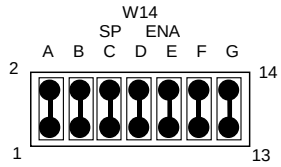
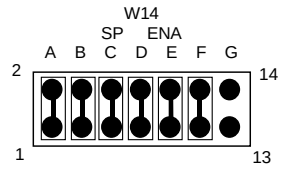
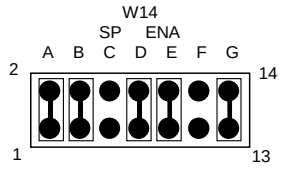
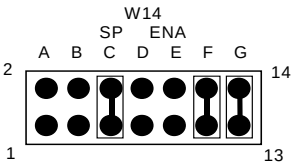
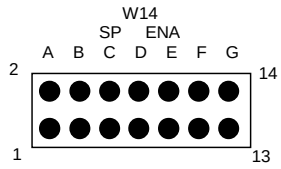
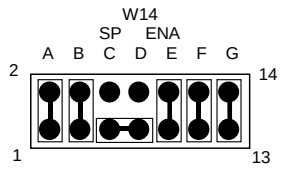
Table 2-1 Jumper Header Positions (Continued)

Header	Position	Effect
FLASH Chip Select, W12 (continued) (Only 1 jumper in this header; do not use position A.)		Selects chip select 2 to control FLASH memory.
Serial Port Enable, W14		Connects all serial-port (UART) signals to RS232 transceivers. **Factory setting.**
		Disables the RS232 driver/buffer.
		Connects port 0 serial-port signals, disconnects port 1 serial port signals.
		Disconnects port 0 serial-port signals, connects port 1 serial port signals.
		Disconnects all serial-port signals.
		Configures the EVB self-test.

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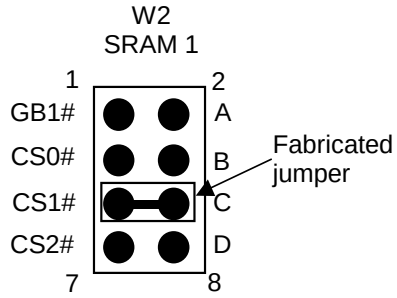
2.1.1 Setting the SRAM Bank 1 Header (W2)

Jumper header W2 selects one of three chip selects for SRAM bank 1. The diagram below shows the factory configuration: the fabricated jumper at position C selects chip select 1.



Alternatively, you may select chip selects 0 or 2. For either of these selections, reposition the W2 fabricated jumper to position B or D, respectively.

NOTE: *You must use jumper headers W2, W8, and W12 to configure chip selects 0, 1, and 2. Although any of these jumper headers can configure any chip select, there must not be any duplication; all three chip selects must be configured.*

CAUTION: *There must be one and only one jumper in header W2 (in position B, C, or D).*

Having a jumper in position A, having multiple jumpers, or having no jumpers could damage the EVB.

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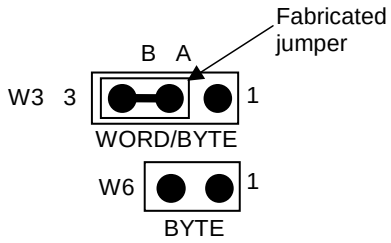
2.1.2 Setting the FLASH Byte/Word Select Headers (W3, W6)

Jumper headers W3 and W6 determine whether the EVB uses FLASH in word or byte mode. The diagram below shows the factory configuration: the fabricated jumper at W3 position B and no fabricated jumper in header W6 configures word mode.



To configure byte mode for the FLASH:

- Reposition the W3 jumper to position A, and
- Put a jumper in header W6.

NOTE: *Do not put the W3 jumper in position A unless you also put a jumper in header W6. Do not put a jumper in header W6 if you put the W3 jumper in position B.*

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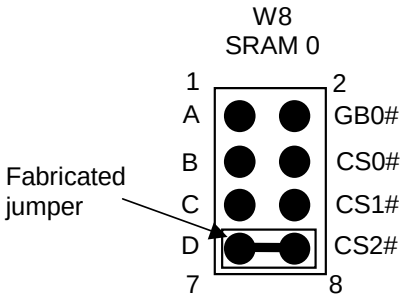
2.1.3 Setting the SRAM Bank 0 Header (W8)

Jumper header W8 selects one of three chip selects for SRAM bank 0. The diagram below shows the factory configuration: the fabricated jumper at position D selects chip select 2.



Alternatively, you may select chip selects 0 or 1. For either of these selections, reposition the W8 fabricated jumper to position B or C, respectively.

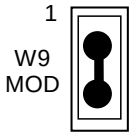
NOTE: *You must use jumper headers W2, W8, and W12 to configure chip selects 0, 1, and 2. Although any of these jumper headers can configure any chip select, there must not be any duplication; all three chip selects must be configured.*

CAUTION: *There must be one and only one jumper in header W8 (in position B, C, or D).*

Having a jumper in position A, having multiple jumpers, or having no jumpers could damage the EVB.

2.1.4 Setting the Startup Vector Select Header (W9)

Jumper header W9 selects the startup vector that the MCU uses upon power-up. The diagram below shows the factory configuration: the fabricated jumper installed in this header selects the vector in the external chip-select 0 device (usually the FLASH memory).



Alternatively, you can select the vector in MCU internal ROM. To do so, remove the jumper from header W9.

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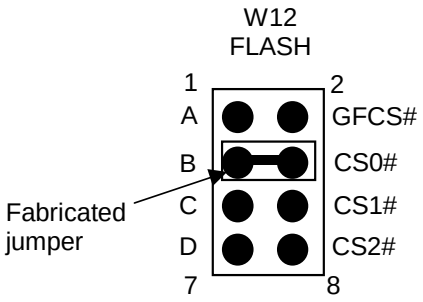
2.1.5 Setting the FLASH Chip Select Header (W12)

Jumper header W12 selects one of three chip selects for FLASH memory. The diagram below shows the factory configuration: the fabricated jumper at position B selects chip select 0. (This is the only correct configuration if you will boot up with the Picobug monitor.)



Alternatively, you may select chip selects 1 or 2. For either of these selections, reposition the W12 fabricated jumper to position C or D, respectively.

NOTE: *You must use jumper headers W2, W8, and W12 to configure chip selects 0, 1, and 2. Although any of these jumper headers can configure any chip select, there must not be any duplication; all three chip selects must be configured.*

CAUTION: *There must be one and only one jumper in header W12 (in position B, C, or D).*

Having a jumper in position A, having multiple jumpers, or having no jumpers could damage the EVB.

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2.1.6 Setting the Serial Port Enable Header (W14)

Jumper header W14 connects or disconnects serial-port (UART) signals from RS232 transceivers. The diagram below shows the factory configuration: the seven fabricated jumpers, in positions A through G, connect the UART signals.

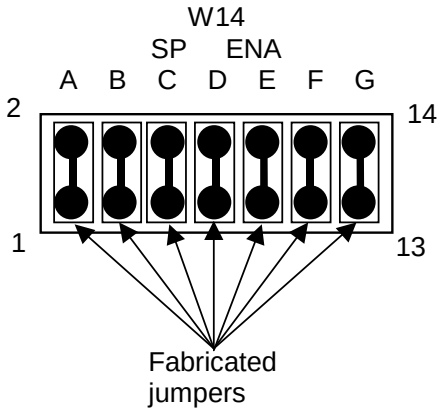

Table 2-2 lists the serial-port signals that correspond to each W14 jumper position. To disconnect a signal, making it available for other use, remove the corresponding jumper. (**Table 2-1** shows such a possible configuration: jumpers removed from positions C and F, disconnecting the port 0 signals.)

Table 2-2 W14 Jumper Signals

UART Signal	Jumper Position
TXD0 – (Transmit data, port 0)	A
CTS0 – (Clear to send, port 0)	B
TXD1 – (Transmit data, port 1)	C
RXD0 – (Receive data, port 0)	D
RTS0 – (Ready to send, port 0)	E
RXD1 – (Receive data, port 1)	F
Transceiver Standby[1]	G

NOTES:

1. Removing the jumper from position G puts driver and receiver outputs in a high-impedance state. To make sure that UART signals of other positions are connected to RS232 transceivers, make sure that a jumper is in position G.

NOTE: *To configure an EVB self-test, remove the jumpers from W14 positions C and D, then insert one of the jumpers turned 90 degrees, so that the jumper connects W14 pins 5 and 7. At the end of the self-test, restore W14 to its correct configuration for operation*

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2.2 Making Computer-System Connections

When you have configured your EVB, you are ready to connect it to your computer system:

1. If you will use the Picobug-GNU debug monitor software, the Motorola FLASH programmer, or another application that needs RS232 connection to port 0, connect an RS232 cable between EVB connector J10 and the appropriate serial port of your computer. If your application will use port 1, connect the port 1 RS232 cable between EVB connector J9 and the appropriate serial port of your computer.
2. If your application will use the OnCE connector, connect a OnCE-compatible cable between EVB connector P5 and the appropriate connector of your computer. (**Section 4 Connector Information** gives pin assignments and signal descriptions for connector P5.)
3. Make sure that your +5-volt power supply is turned off (or disconnected from line power). Connect the power supply's ground wire to pin 1 (black) of EVB connector J8. Connect the power supply's power wire to pin 2 (red) of connector J8.
4. If you have not already done so, apply power to your computer. Turn on your +5-volt power supply (or connect it to line power): the green LED (DS5) lights to confirm that the EVB is powered. (Should the DS5 LED *not* light, you may need to replace the fuse at location F1, next to power connector J8. Use a BUS GMA-1.5A fuse, or compatible.)
5. This completes system connections; you are ready to perform an EVB self-test, per the instructions of **2.3 Performing the EVB Self-Test**, below. You are ready to begin debugging or other development activities, per the instructions of **Section 3 Operation**.
6. (Optional) For scope observation of specific I/O or interrupt signals, you may use connectors P1, P2A, or P2B. You may clip individual lines to the pins of these connectors, or use appropriate connectors. (**Section 4 Connector Information** gives pin assignments and signal descriptions for these connectors.)

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2.3 Performing the EVB Self-Test

Once you have configured your EVB, you can perform a self-test of EVB components.

1. If your EVB is powered, turn off or disconnect power. The green LED (DS5) goes out.
2. Make sure that a fabricated jumper is in jumper header W9.
3. Remove the fabricated jumpers from positions C and D of jumper header W14. Turn one of these jumpers 90 degrees, then reinsert it, so that it connects W14 pins 5 and 7.
4. (Optional) Activate Hyperterminal and connect it to EVB connector J10. From the Hyperterminal File menu select Properties. Click on the Configure button of the properties dialog box. Use the configure dialog box to set 19200 baud, 8 data bits, no parity, 1 stop bit, and no flow control.
5. Apply power to the EVB. The green LED (DS5) comes on to confirm power. The EVB automatically begins its self-test.
6. The four yellow LEDs (DS1 through DS4) flicker during the self-test (approximately one minute), then light without flickering to confirm that the EVB passed the self-test.
7. If, at the end of the self-test, any of the yellow LEDs does not light without flickering, the EVB fails the self-test. (If you have activated Hyperterminal per step 4, your computer monitor displays a failure message that will help you find and correct the problem.)

   After you correct the problem, repeat the self-test. Should the failure persist, you may need to contact Motorola customer support for assistance.
8. When the EVB passes the self-test, disconnect power, restore jumper header W14 to its operating configuration, then restore power. This completes the self-test.

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2.4 Using the Breadboard (Optional)

Use the three ribbon cables that come with the EVBPROTO beadboard to connect it to your EVB:

1. Run one cable from breadboard connector J1 to EVB connector P1. Make sure that the red-striped wire of the cable is at the pin-1/pin-2 end of both connectors. (With regard to **Figure 1-1**, the red-striped wire should be at the bottom connector end.)
2. Run another cable from breadboard connector J2 to EVB connector P2A. Make sure that the red-striped wire of the cable is at the pin-1/pin-2 end of both connectors. (With regard to **Figure 1-1**, the red-striped wire should be at the left connector end.)
3. Run the third cable from breadboard connector J3 to EVB connector P2B. For the breadboard connection, the red-striped wire of the cable should be at the pin-1/pin-2 end of the connector. For the EVB connection, the *unstriped* wire of the cable should be at the pin-99/pin-100 end of the connector, according to the silk-screen markings. (With regard to **Figure 1-1**, the red-striped wire should be at the left connector end, the unstriped cable wire should be at the right connector end.)

This completes cable connections. Instead of accessing a signal at one of the three EVB connectors, you may access the signal at the corresponding header pad of the breadboard:

- You may solder a wire in the appropriate hole.
- You may solder a post in the appropriate hole. This lets you use a small clip or wire wrap to access the signal.
- You may solder a 2-by-20-pin header in place at the pad. This lets you use small clips or wire wraps to access any of the signals. (Motorola ships 2-by-20-pin headers with your EVB.)

To add your own component to the main breadboard area, insert the component's leads through the holes in the board, then solder the leads in place. Run appropriate wires from the component to power and ground locations.

You may add surface-mount components to spare pads similarly. The three pad sizes are:

- 50 mils pitch by 220 mils width,
- 25.6 mils pitch by 254 mils width, and
- 50 mils pitch by 380 mils width.

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Solder the component's leads to the appropriate solder bars to hold he component in position. Then run appropriate wires from the small adjacent vias to board power, ground, or signal locations.

NOTE: *If you do add components in the breadboard or spare-pad areas, make sure that their current draw does not exceed the EVB power supply limits.*

2.5 Memory Maps

The configuration of jumper headers W2, W8, and W12 determines which chip selects are active. **Table 2-3** lists the memory-map starting and ending addresses for all such possibilities (bold type indicates the factory configuration).

Table 2-3 MMC2001 Address-Decoded Memory Map

Memory	Jumper Header, Jumper Position	Chip Select	Starting Address	Ending Address
FLASH	**W12 – B**	**CS0**	**0x2D00_0000**	**0x2D0F_FFFF**
	W12 – C	CS1	0x2F00_0000	0x2F0F_FFFF
	W12 – D	CS2	0x2E00_0000	0x2E0F_FFFF
SRAM Bank 0	W8 – B	CS0	0x2D00_0000	0x2D0F_FFFF
	W8 – C	CS1	0x2F00_0000	0x2F0F_FFFF
	W8 – D	**CS2**	**0x2E00_0000**	**0x2E0F_FFFF**
SRAM Bank 1	W2 – B	CS0	0x2D00_0000	0x2D0F_FFFF
	W2 – C	**CS1**	**0x2F00_0000**	**0x2F0F_FFFF**
	W2 – D	CS2	0x2E00_0000	0x2E0F_FFFF

As the table shows, the factory configuration:

- Puts FLASH memory into the chip-select 0 memory space (addresses 0x2D00_0000 through 0x2D0F_FFFF),
- Puts SRAM bank 0 memory into the chip-select 2 memory space (addresses 0x2E00_0000 through 0x2E0F_FFFF), and
- Puts SRAM bank 1 memory into the chip-select 1 memory space (addresses 0x2F00_0000 through 0x2F0F_FFFF).

NOTE: *Each SRAM bank occupies 64 kilobytes of memory: one eighth of the megabyte a chip select reserves. Accordingly, the EVB mirrors SRAM contents. That is, it puts eight copies of the data into the megabyte of memory. This makes memory contents contiguous, despite the smaller size of an SRAM bank.*

The MMC2001 resident MCU is at EVB location U7. The first 12 kilobytes of this MCU's internal RAM (starting address 0x3000_0000) is reserved for the Mbug, Picobug, and FLASH programmer algorithms.

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Section 3 Operation

This chapter explains how to begin using debugging tools available for your MMCEVB1200PV Evaluation Board, as well as how to use Motorola's FLASH programmer.

3.1 Debugging Embedded Code

With your EVB, you may use the Picobug debug monitor, as standalone software. Optionally, you may use the GNU source-level debugger with the Picobug monitor. Other firms may produce still additional software to run, test, and modify the code you develop for embedding in an MMC2001 MCU.

3.1.1 Using the Picobug Debug Monitor

The Picobug debug monitor comes burned into the FLASH memory device of your EVB (location U3). Before you start the Picobug monitor, make sure that you have an RS232 connection between EVB connector J10 and a serial port of your computer.

To start the Picobug monitor, for use as a standalone debugger:

1. Make sure that power is *not* applied to your EVB.
2. Activate Hyperterminal or a comparable terminal-emulation program. (If you use a different terminal-emulation program, you must make corresponding changes in the commands and menu selections of these instructions, and in the instructions of **3.1.2 Picobug Sample Session**.)
3. From the File menu, select Properties. This opens a properties dialog box.
4. Click on the Configure button of the dialog box. This opens a configuration dialog box.
5. Use the configuration dialog box to set the operating speed (19,200) and the correct communications port (for example, COM1). Click the OK button of the dialog box.
6. The Picobug monitor starts automatically, as soon as you apply power to the EVB. Note the command prompt: `picobug>`.

To use the Picobug debug monitor, merely enter commands at the prompt. **Table 3-1** explains these commands. To see a list of these commands on your computer screen, enter a question mark or the extra command `help` at the command prompt.

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Table 3-1 Picobug Commands

Command	Explanation
br [*address*]	Breakpoint: • With optional *address* value, sets a new breakpoint at that address. • Without any *address* value, lists all current breakpoints.
g [*address*]	Go: • With optional *address* value, starts code execution from that address. • Without any *address* value, starts code execution from the current program-counter value. In either case, execution stops when it arrives at a breakpoint.
gr	Go to Return: Executes code from the current program-counter value to the return address of the calling routine. (Should execution arrive at a breakpoint before encountering the return address, execution stops at the breakpoint.)
gt *address*	Go to Address: Executes code from the current program-counter value to the specified *address* value. (Should execution arrive at a breakpoint before encountering the specified address, execution stops at the breakpoint.)
lo [*address*]	Download: • With optional *address* value, downloads a binary image to that address in SRAM. • Without any *address* value, downloads to SRAM an S-record text file.
md *address1 address2* [;*size*]	Memory Display: Displays memory contents from the *address1* value to the *address2* value. The optional *size* value specifies the format: **b** (bytes, the default), **h** (half words), **w** (words), or **i** (instructions).
mds *address* [;*size*]	Memory Display: Displays 256 bytes of memory contents, beginning at the *address* value. The optional *size* value specifies the format: **b** (bytes, the default), **h** (half words), **w** (words), or **i** (instructions).
mm *address* [value] [;*size*]	Modify Memory: • With optional *value* parameter value, assigns that value to the *address* location. • Without any *value* parameter value, prompts for a value for the *address* location, then prompts for a new value for the next location. To stop modification, enter a period instead of a new value. • The optional *size* value specifies the format: **b** (bytes, the default), **h** (half words), **w** (words), or **i** (instructions).
nobr [*address*]	No Breakpoint: • With optional *address* value, removes the breakpoint from that address. • Without any *address* value, removes all the breakpoints.
reset	Reset: Resets the CPU and peripherals.
rd [*name*]	Register Display: • With optional *name* value, displays the value of that CPU register. • Without any *name* value, displays the values of all CPU registers.
rm *name value*	Register Modify: Assigns the *value* parameter value to the *name* CPU register.
t	Trace (Step): Single steps one instruction; identical to the `s` command.
s	Step (Trace): Single steps one instruction; identical to the `t` command.

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3.1.2 Picobug Sample Session

1. This sample session begins with the Picobug prompt:

```
picobug
```

2. To see the contents of all registers, enter the Register Display (rd) command without any name value:

```
picobug>    rd
```

The system responds with a display such as this:

```
     pc 30000286  epc      30000286  fpc      0010a000
    psr 80000100  epsr     80000100  fpsr     00020000
ss0-ss4 bad0beef  20000c00 20008000  20010042 00000801  vbr      30005c00
  r0-r7 300027f8  00000050 0000ea60  30005f94 30006708  80070101 00000200 00000040
 r8-r15 0010a000  00020000 20000c00  300067c0 00000000  30005f94 10005000 30000286
```

3. To see the contents of a specific register, such as the epc register, enter the Register Display (rd) command *with* the name value:

```
picobug> rd epc
```

The system responds with a display such as this:

```
epc:     30000286
```

4. To see the contents of a specific memory location, enter the Memory Display (md) command with the location address. An optional size value (in this case w, for word) may be part of the command:

```
picobug> md    0x30001000  ;w
```

The system responds with a display such as this:

```
30001000:  8EF0B37E
```

5. To see the contents of a memory range, enter the Memory Display (md) command with the beginning and ending addresses. An optional size value (in this case b, for byte) may be part of the command:

```
picobug> md    0x30000000  0x30000010  ;b
```

The system responds with a display such as this:

```
30000000: 8E F0 00 00 55 55 55 55 0E 22  9E E8 03 20 0D 20 0E $..UUUU. "… . .
30000010: F7
```

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6. To download into SRAM a program executable, in S-record format, enter the Download (lo) command without any address value:

```
picobug> lo
```

The system waits for you to send the program executable file. To do so, open the Transfer menu and select Send Text File. This opens a file-select dialog box. Use this dialog box to specify the appropriate S-record file, then click on the Open button. When the file-select dialog box disappears, press the Enter key of your keyboard. (Pressing the keyboard Enter key adds a necessary line-feed character to the end of the S-record file.) As soon as the download is complete (this may take several minutes), the Picobug prompt reappears:

```
picobug>
```

7. To see the new contents of registers, enter the Register Display (rd) command again, without any name value:

```
picobug> rd
```

The system responds with an updated display, which shows that the pc register value reflects the start of the program just downloaded:

```
     pc 3000022a  epc      2d00108a  fpc      0010a000
    psr 80000000  epsr     80070101  fpsr     00020000
ss0-ss4 bad0beef  20000c00 20008000  20010042 00000801  vbr      30005c00
  r0-r7 bad0beef  00000050 00000000  d89f69ab 30005f20  80000000 00000200 00000024
 r8-r15 0010a000  300066b8 300067d7  30006948 30006714  30006708 300067c8 2d0001c4
```

8. To set a breakpoint at address 0x3000025C, enter this address as part of the Breakpoint (br) command:

```
picobug> br   0x3000025c
```

The Picobug prompt reappears, confirming that the system set the breakpoint:

```
picobug>
```

9. To see the list of breakpoints, enter the Breakpoint (br) command *without* any address value:

```
picobug> br
```

The system responds with the addresses of breakpoints, in this case only the breakpoint set in step 8:

```
3000025C
```

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10. To start program execution, enter the Go (g) command:

```
picobug> g
```

In this instance, the breakpoint set during step 8 stops code execution. The system responds with this new display of register values:

```
 At breakpoint!!
    pc 3000025c  epc      3000025c  fpc      0010a000
   psr 80000100  epsr     80000100  fpsr     00020000
ss0-ss4 bad0beef  20000c00 20008000  20010042 00000801  vbr      30005c00
  r0-r7 300027f8  00000050 0000ea60  d89f69ab 30005f20  80000000 00000200 00000040
 r8-r15 0010a000  300066b8 300067d7  30006948 30006714  30006708 10005010 300002a2
```

11. To remove all breakpoints, enter the No Breakpoint (nobr) command, without any address value:

```
picobug> nobr
```

The Picobug prompt reappears, confirming that the system has removed the breakpoints:

```
picobug>
```

12. To see the list of breakpoints again, once more enter the Breakpoint (br) command without any address value:

```
picobug> br
```

As there are no longer any breakpoints, the system responds with the Picobug prompt:

```
picobug>
```

13. To continue with this example session, enter another appropriate command. For example, to resume program execution, enter the Go (g) command.
14. To end your Picobug session, remove power from the EVB and close the terminal-emulation program.

3.1.3 Using the GNU Source-Level Debugger

The GNU source-level debugger is on the CD-ROM that comes with your EVB. This GNU software works with the Picobug debug monitor to provide source-level debugging for your code.

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The EVB product release guide gives the instructions for loading the GNU software, and for making any connections different from standalone Picobug connections.

3.2 Downloading to FLASH Memory

Motorola's FLASH programmer lets you program your code into FLASH memory, verify that FLASH contents match those of a download file, display the contents of FLASH memory, erase FLASH memory, or erase a sector of FLASH memory.

3.2.1 Using the FLASH Programmer

Follow these steps to use the programmer:

1. If you have not already installed the FLASH programmer onto your computer hard disk, do so. The EVB product release guide includes installation instructions.
2. Reset the EVB, by pressing switch S1.
3. Start the FLASH programmer. The main screen (**Figure 3-1**) appears.

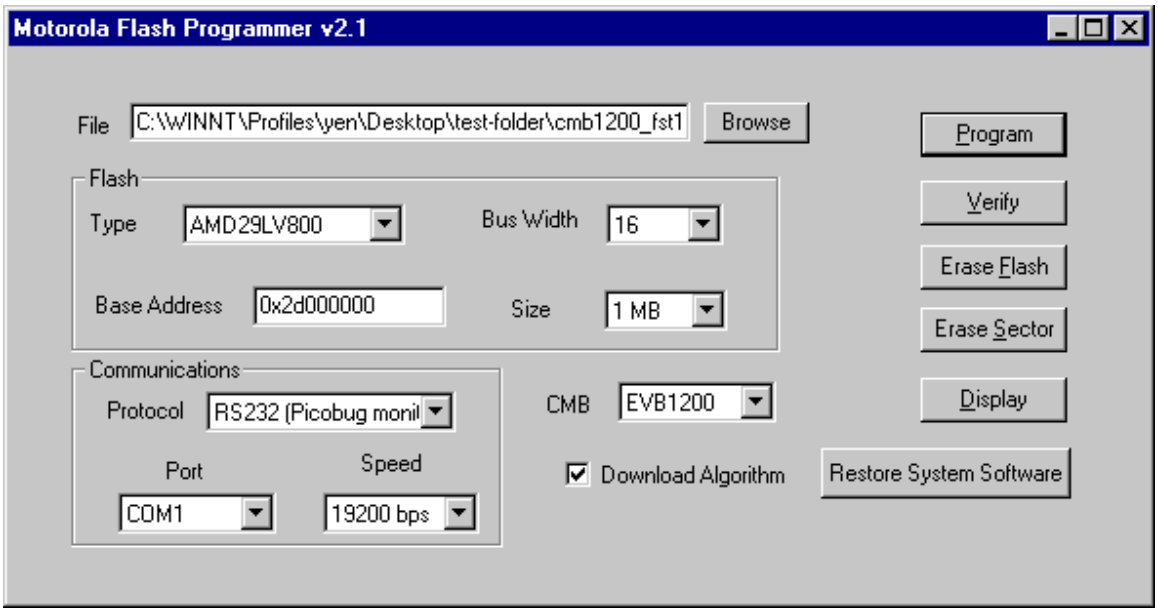

Figure 3-1 FLASH Programmer Main Screen

NOTE: ***Figure 3-1*** *shows field values appropriate for using the FLASH programmer with an EVB. Except as explained in the instructions below, selecting different values for these fields could cause errors.*

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4. Go to the File field, at the upper left of the main screen.
   - If you know the full pathname of the file to be programmed, enter the pathname in this field.
   - If you do not know the full pathname of the file to be programmed, click on the Browse button. This brings up a standard file-select dialog box: select the file and click on the OK button. This returns you to the main screen, entering the pathname in the File field.
5. Use the Flash area of the main screen to configure the FLASH type, bus width, and size.

   In the Base Address field, enter the FLASH starting address for the chip select you configured via jumper header W12:
   - For chip select 0, enter base address 0x2d000000.
   - For chip select 1, enter base address 0x2f000000.
   - For chip select 2, enter base address 0x2e000000.
6. In the Communications area of the main screen, use the Port field to specify the PC serial port, and use the Speed field to specify the communications rate (19200 bps).

   Use the Protocol field to specify the communications protocol:
   - If your computer connects to the EVB through a serial port, and the EVB system software is intact, specify RS232 (Picobug monitor). **Figure 3-2** illustrates this selection.

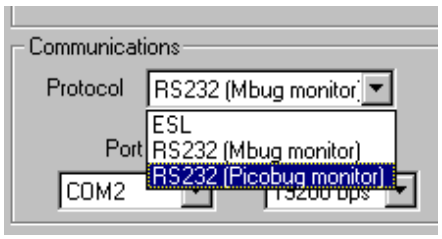

Figure 3-2 Picobug Protocol Selection

   - If your computer connects to the EVB OnCE connector through an EBDI box, specify ESL
   - If your computer connects to the EVB through a serial port, but the EVB system software has been deleted, specify RS232 (Mbug monitor).

NOTE: *If you select the RS232 (Mbug monitor) protocol, a prompt tells you to remove the W9 jumper and reset the EVB. Even if you just have reset the EVB, you must reset it again, after removing the W9 jumper.*

You may set the protocol, port, and speed only once during each programmer session. To make another change in any Communications-area setting, you must exit, then restart, the FLASH programmer.

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7. Go to the CMB field, near the lower center of the main screen. Make sure that the field specifies EVB1200. Make sure that the Download Algorithm box is checked.

   This completes the programmer setup. You are ready for the programming actions that correspond to the buttons along the right edge of the main screen.

8. To program FLASH memory, click on the Program button. The software downloads the file you specified, displaying a progress message. A Download successful message appears at the end of downloading: you are ready to use the code in FLASH memory.

   - If this is the first programming action of this FLASH programmer session, the software downloads an algorithm file before downloading the file you specified. A progress message appears during the downloading of this algorithm file.
   - If the software cannot find the algorithm file, an appropriate error message identifies the file. Click on the message's OK button to bring up a file-select dialog box, then use this dialog box to specify the location of the algorithm file. If necessary, recopy the file from the transmittal CD-ROM. Click on the OK button to resume programming FLASH memory.
   - The error message Unable to Validate Flash configuration indicates some problem with the programming. A likely such problem is that the chip select base address does not correspond to the configured chip select. Correct the problem, then click again on the Program button.

NOTE: *Another possible cause of validation failure is that the link control file of user code specifies SRAM, not FLASH, as the download destination. You must correct such a problem in the user code.*

9. To verify that the contents of Flash memory match the selected download file, click on the Verify button. A progress message appears as verification begins. A Verify successful message appears at the end of verification.

   - If this is the first programming action of this FLASH programmer session, the software downloads an algorithm file before verifying FLASH. A progress message appears during the downloading of this algorithm file. (Should the software be unable to find the algorithm file, an appropriate error message appears, as explained under step 8, program FLASH memory, above.)
   - If verification fails, an error message specifies the location that did not have the expected contents.
   - To recover from a verification failure, try programming Flash again, to replace the selected download file.

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NOTE: *Another possible cause of verification failure is that the link control file of user code specifies SRAM, not FLASH, as the download destination. You must correct such a problem in the user code.*

10. To erase FLASH memory, click on the Erase Flash button. The programmer erases all contents of the FLASH memory except for sector 0 (which contains the system software). Erasing takes 20 to 30 seconds.

    If this is the first programming action of this FLASH programmer session, the software downloads an algorithm file before erasing FLASH. A progress message appears during the downloading of this algorithm file. (Should the software be unable to find the algorithm file, an appropriate error message appears, as explained under step 8, program FLASH memory, above.)

11. To erase a sector of FLASH memory, click on the Erase Sector button. This brings up the Flash Sector Number dialog box. Enter the number of the sector to be erased, then click on the OK button.

    - If this is the first programming action of this FLASH programmer session, the software downloads an algorithm file before erasing the FLASH sector. A progress message appears during the downloading of this algorithm file. (Should the software be unable to find the algorithm file, an appropriate error message appears, as explained under step 8, program FLASH memory, above.)
    - If you specify sector 0, a message reminds you that the system software is in this section. Buttons of the message box let you cancel the erasure or proceed with the erasure.

NOTE: *The target FLASH device has 16 sectors, 0 through 15, each of 64 kilobytes. Do not erase sector 0, which contains system software, unless it is absolutely necessary. (If you must erase sector 0, you subsequently can restore factory programming by clicking on the Restore System Software button.* ***3.2.2 Restoring Factory Programming*** *gives additional information about restoring sector 0.)*

12. To view the contents of Flash memory, click on the Display button. This brings up the Memory Contents display (**Figure 3-3**).

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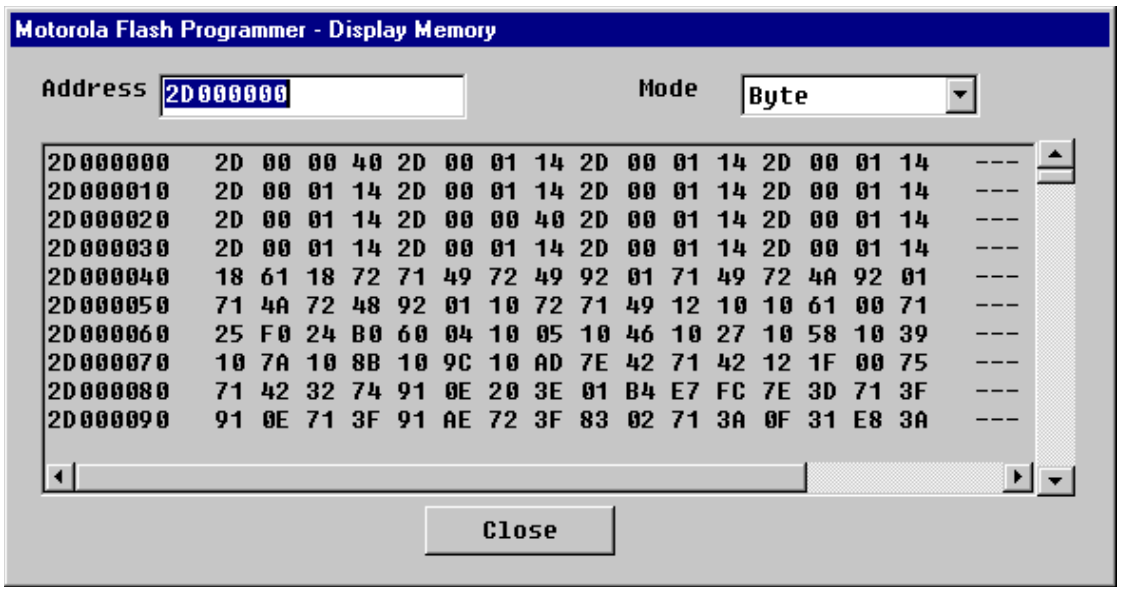

Figure 3-3 Memory Contents Display

- If this is the first programming action of this FLASH programmer session, the software downloads an algorithm file before displaying FLASH contents. A progress message appears during the downloading of this algorithm file. (Should the software be unable to find the algorithm file, an appropriate error message appears, as explained under step 8, program FLASH memory, above.)
- The Address field shows the first address of the value display. One way to change the display is to enter a different address in this field.
- Another way to change the value display is to use the vertical or horizontal scroll bars.
- Use the Mode field to specify byte, half-word, or word values in the display.
- When you are done viewing the display, click on the Close button to return to the main screen.

13. At the end of your programming session, click on the Exit button.

3.2.2 Restoring Factory Programming

If you must overwrite FLASH-device sector 0, you subsequently may use the FLASH programmer to restore Picobug and other factory software to sector 0. To do so, select the RS232 (Mbug monitor) communications protocol. Then click on the Restore System Software button.

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- If the system software is in your current hard-disk directory, the FLASH programmer automatically restores factory programming to FLASH sector 0. The main screen reappears to confirm successful programming.
- If you receive a message that the system software does not exist, it may be because the software is in a different hard-disk directory. If so, make that directory the active one and click again on the Restore System Software button.
- The CD-ROM that comes with your EVB is yet another source of system software: files `Dev_Sys/MMC2001/SYSsw_FLASHprog/mon.elf` and `Dev_Sys/MMC2001/SYSsw_FLASHprog/bist.elf`.

3.3 Controlling EVB LEDs

Section 2 Configuration explained how the four yellow EVB LEDs flicker and light as part of the EVB self-test. Your own code also can control these LEDs, which are connected to pins PWM0 through PWM3 of the microprocessor.

Table 3-2 lists the control register names and addresses for each LED.

Table 3-2 LED Registers and Addresses

LED Location	Register	Address
DS1	PWM0	0x10005000
DS2	PWM1	0x10005008
DS3	PWM2	0x10005010
DS4	PWM3	0x10005018

To control an LED, your code must assign appropriate values to the LED's control register. Your code must:

1. Assign the value 1 to the data direction bit (bit 6). (This makes the microprocessor pin an output pin.)
2. Assign the value 0 to the mode bit (bit 4). (This configures general-purpose I/O mode.)
3. To turn the LED ON, assign the value 0 to the data bit (bit 7), or
4. To turn the LED OFF, assign the value 1 to the data bit (bit 7).

For example, this line of C code will turn ON LED DS1:

```
*(unsigned short) (0x10005000) = 0x0040;
```

This line of code will turn OFF LED DS3:

```
*(unsigned short) (0x10005010) = 0x00C0;
```


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Operation

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Section 4 Connector Information

This chapter consists of pin assignments and signal descriptions for EVB connectors P1, P2A, P2B, and P5. (This chapter does not cover the standard connectors J8, J9, or J10.)

4.1 I/O and Interrupt Connectors (P1, P2A, P2B)

Connectors P1, P2A, and P2B, all 2-by-20-pin connectors, are the EVB I/O and interrupt connectors. **Figure 4-1**, **Figure 4-2**, and **Figure 4-3**, respectively, give the pin assignments for these connectors. **Table 4-1**, **Table 4-2**, and **Table 4-3**, respectively, give the signal descriptions for these connectors.

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Connector Information

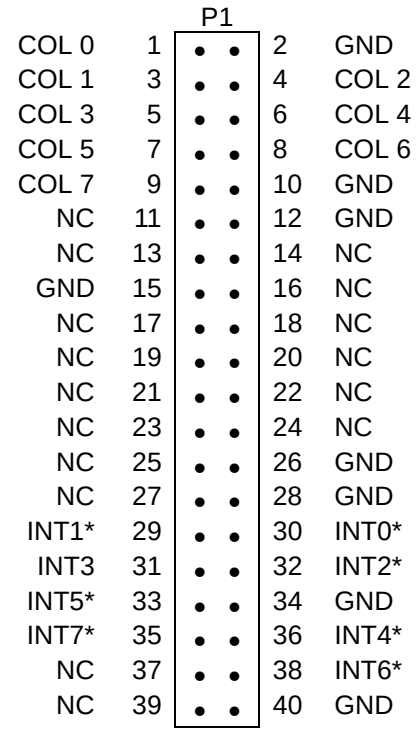
P1
COL 0 1 2 GND
COL 1 3 4 COL 2
COL 3 5 6 COL 4
COL 5 7 8 COL 6
COL 7 9 10 GND
NC 11 12 GND
NC 13 14 NC
GND 15 16 NC
NC 17 18 NC
NC 19 20 NC
NC 21 22 NC
NC 23 24 NC
NC 25 26 GND
NC 27 28 GND
INT1* 29 30 INT0*
INT3 31 32 INT2*
INT5* 33 34 GND
INT7* 35 36 INT4*
NC 37 38 INT6*
NC 39 40 GND

Figure 4-1 Connector P1 Pin Assignments

NOTE: *The same signal assignments apply to the P1 header pad of the EVBPROTO breadboard, provided that a ribbon cable runs between breadboard connector J1 and EVB connector P1. The red-striped wire of the cable must be at the pin-1/pin-2 ends of both connectors.*

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Table 4-1 Connector P1 Signal Descriptions

Pin	Mnemonic	Signal
1, 3 – 9	COL 0 – COL 7	COLUMN STROBES (lines 0–7) – Keypad column strobe lines, open-drain selectable via software. (Default state upon reset is general-purpose input.)
2, 10, 12, 15, 26, 28, 34, 40	GND	GROUND
11, 13, 14, 16 25, 27, 37, 39	NC	No connection
29 – 33, 35, 36, 38	INT1*, INT0*, INT3, INT2*, INT5*, INT7*, INT4*, INT6*	EXTERNAL INTERRUPTS (lines 1, 0, 3, 2, 5, 7, 4, 6) – Bidirectional interrupt lines that form the external interface to the general-purpose I/O module. (Except for INT3, all are active low.)

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Connector Information

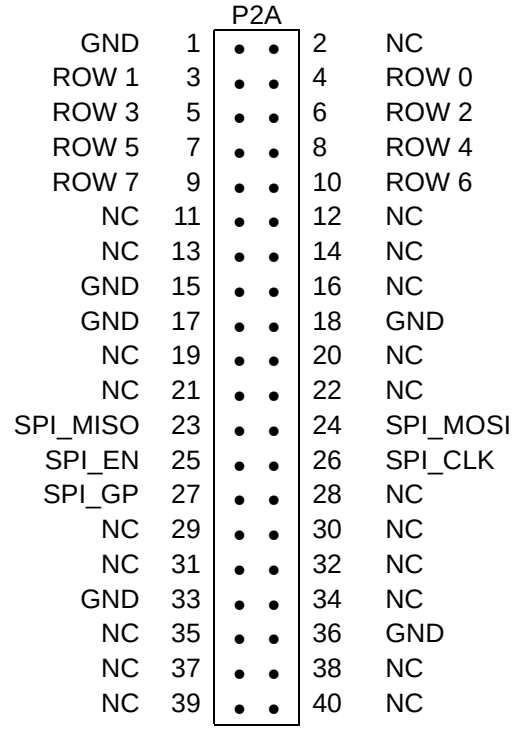
P2A
GND 1 2 NC
ROW 1 3 4 ROW 0
ROW 3 5 6 ROW 2
ROW 5 7 8 ROW 4
ROW 7 9 10 ROW 6
NC 11 12 NC
NC 13 14 NC
GND 15 16 NC
GND 17 18 GND
NC 19 20 NC
NC 21 22 NC
SPI_MISO 23 24 SPI_MOSI
SPI_EN 25 26 SPI_CLK
SPI_GP 27 28 NC
NC 29 30 NC
NC 31 32 NC
GND 33 34 NC
NC 35 36 GND
NC 37 38 NC
NC 39 40 NC

Figure 4-2 Connector P2A Pin Assignments

NOTE: *The same signal assignments apply to the P2A header pad of the EVBPROTO breadboard, provided that a ribbon cable runs between breadboard connector J2 and EVB connector P2A. The red-striped wire of the cable must be at the pin-1/pin-2 ends of both connectors.*

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Table 4-2 Connector P2A Signal Descriptions

Pin	Mnemonic	Signal
1, 15, 17, 18, 33, 36	GND	GROUND
2, 11 – 14, 16, 19 – 22, 28 – 32, 34, 35, 37 – 40	NC	No connection
3 – 10	ROW 1, ROW 0, ROW 3, ROW 2, ROW 5, ROW 4, ROW 7, ROW 6	ROW SENSES (lines 1, 0, 3, 2, 5, 4, 7, 6) – Keypad row sense lines. (On-chip 47KΩ pull-up resistors are connected to these lines; the default state upon reset is general-purpose input.)
23	SPI_MISO	SPI DATA MASTER IN/SLAVE OUT – In master mode, serial data input line to the serial peripheral interface of the MCU. In slave mode, serial data output line from the serial peripheral interface.
24	SPI_MOSI	SPI DATA MASTER OUT/SLAVE IN – In master mode, serial data output line from the serial peripheral interface module of the MCU. In slave mode, serial data input line to the serial peripheral interface.
25	SPI_EN	SPI ENABLE – In master mode, the peripheral chip-select line. In slave mode, the slave enable line.
26	SPI_CLK	SPI SERIAL CLOCK – Serial shift clock line for the serial peripheral interface module.
27	SPI_GP	SPI GENERAL-PURPOSE OUTPUT – Serial peripheral interface module output line: a control line for external logic or devices.

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Connector Information

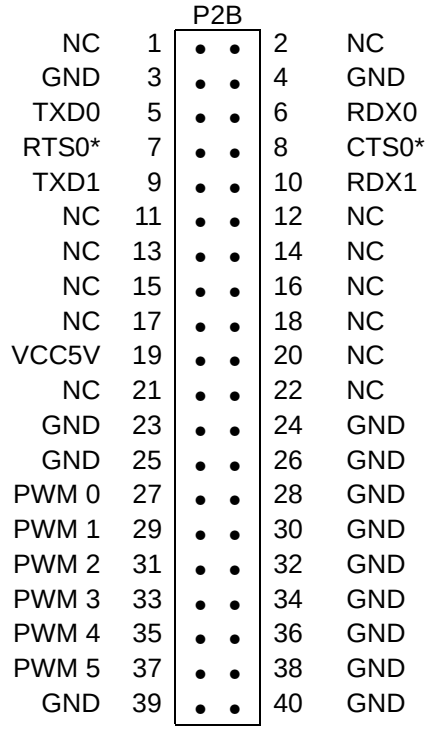
P2B
NC 1 2 NC
GND 3 4 GND
TXD0 5 6 RDX0
RTS0* 7 8 CTS0*
TXD1 9 10 RDX1
NC 11 12 NC
NC 13 14 NC
NC 15 16 NC
NC 17 18 NC
VCC5V 19 20 NC
NC 21 22 NC
GND 23 24 GND
GND 25 26 GND
PWM 0 27 28 GND
PWM 1 29 30 GND
PWM 2 31 32 GND
PWM 3 33 34 GND
PWM 4 35 36 GND
PWM 5 37 38 GND
GND 39 40 GND

Figure 4-3 Connector P2B Pin Assignments

NOTE: *The same signal assignments apply to the P2B header pad of the EVBPROTO breadboard, provided that a ribbon cable runs between breadboard connector J3 and EVB connector P2B. The unstriped wire of the cable must be at the pin-39/pin-40 ends of both connectors. That is, for EVB connector P2B, the unstriped wire of the cable must be at the end with the silkscreen markings 99 and 100.*

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Table 4-3 Connector P2B Signal Descriptions

Pin	Mnemonic	Signal
1, 2, 11 – 18, 20 – 22	NC	No connection
3, 4, 23 – 26, 28, 30, 32, 34, 36, 38 – 40	GND	GROUND
5, 9	TXD0, TXD1	TRANSMIT DATA (lines 0, 1) – Output data transmission lines for UART channels 0 and 1.
6, 10	RXD0, RXD1	RECEIVE DATA (lines 0, 1) – Input data receive lines for UART channels 0 and 1.
7	RTS0*	REQUEST TO SEND 0 – Active-low input line that can be programmed as the request-to-send signal for UART channel 0.
8	CTS0*	CLEAR TO SEND 0 – Active-low output line that can be programmed as the clear-to-send signal for UART channel 0.
19	VCC5V	OPERATING VOLAGE – Transmission line for +5-volt MCU operating power.
27, 29, 31, 33, 35, 37	PWM 0 – PWM 5	PULSE WIDTH MODULATOR (lines 0–5) – External interface lines for the pulse width modulator block. (Default state upon reset is general-purpose input.)

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4.2 OnCE Connector (P5)

Connector P5, a 2-by-7-pin connector, conveys data and control signals to and from the OnCE control block. **Figure 4-4** and **Table 4-4** give the pin assignments and signal descriptions for this connector.

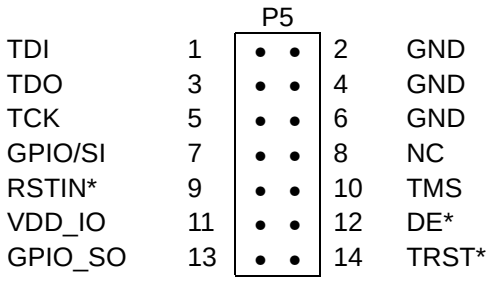

Figure 4-4 OnCE Connector P5 Pin Assignments

Table 4-4 OnCE Connector P5 Signal Descriptions

Pin	Mnemonic	Signal
1	TDI	DEBUG SERIAL INPUT – Data and command input line to the OnCE controller.
2, 4, 6	GND	GROUND
3	TDO	DEBUG SERIAL OUTPUT – Serial data output line from the OnCE controller.
5	TCK	DEBUG SERIAL CLOCK – Serial clock input line to the OnCE control block.
7	GPIO/SI	GENERAL-PURPOSE I/O SERIAL IN – General-purpose input line to the OnCE controller.
8	NC	No connection
9	RSTIN*	RESET IN – Active-low input line to the OnCE controller, signalling a reset.
10	TMS	DEBUG MODE SELECT – Input signal that tells the OnCE control block to advance one mode state (of the cycle of mode states).
11	VDD_IO	OPERATING VOLTAGE – Transmission line for +5-volt MCU operating power.
12	DE*	DEBUG EVENT – Active-low debug-mode control line for the OnCE controller. An input signal from an external command controller makes the OnCE controller immediately enter debug mode. An output signal acknowledges debug-mode-entry to the external command controller.
13	GPIO_SO	GENERAL-PURPOSE I/O SERIAL OUT – General-purpose output line from the OnCE controller.
14	TRST*	TEST RESET – Active-low input line for an external reset signal to the OnCE controller.

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Revision History

Revision	Page Number	Summary of Changes
1.0	ii	ESD protection caution not in the original version of this manual.
1.0	3-7 through 3-14	Explanation of the new FLASH programmer replaced the original manual's explanation of earlier software.
2.0	All	Entire document has been reformatted to conform to new documentation styles.
2.0	9, 12, 13, 25, 26	Includes information on the new breadboard.
2.0	32, 36, 37	Reflects changes to the FLASH programmer.

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